

# **METHOD AND APPARATUS FOR CONTROLLING A VALVE DURING A HAZARD EVENT**

## **BACKGROUND**

### **I. FIELD**

[0001] The present invention relates generally to transportation and delivery systems, and more particularly, to a method and apparatus for controlling a valve for use with a vehicle transporting hazardous materials when a hazard event is detected.

### **II. DESCRIPTION OF THE RELATED ART**

[0002] Advances in technology have provided for increased automation in many industries. For example, in the trucking industry, technology has allowed for the shipment and delivery of cargo virtually around the clock. Vehicles now carry and deliver cargo to all parts of the country. For example, cargo-carrying tractor-trailers may be driven hundreds or thousands of miles to reach a delivery site.

[0003] Typically, cargo is loaded into a trailer portion of a tractor-trailer vehicle and driven from point to point along a delivery route by a vehicle operator. Along the delivery route, intermediate stops may occur where portions of the cargo are unloaded for delivery or where new cargo is picked up. To facilitate efficient routing, sometimes a trailer is detached from its current tractor and left at a designated location for pickup by another tractor. The trailer may sit at this intermediate location for various lengths of time while waiting to be retrieved by another tractor. This detachable trailer arrangement allows shippers to plan the most efficient and cost effective routes for the delivery of the cargo. In some cases, the trailer acts as a storage container to store the cargo for an extended period of time.

[0004] Generally speaking, the vast majority of cargo carried by the trucking industry represents food or other consumer goods that do not pose a danger to the public during transportation. However, the trucking industry also transports hazardous materials (HAZMAT) that may pose a threat to the general public or the environment. For example, materials such as fuels, chemicals, oil, waste materials, or other hazardous materials may pose a serious risk to the public in the event of a vehicle accident, malfunction, or hijacking. For example, if a truck carrying a cargo of dangerous chemicals is involved in an accident, leakage of the chemicals may endanger lives or pose a serious risk to the environment.

[0005] Another problem facing the transportation industry is the threat of theft or hijacking to steal hazardous cargo from vehicles during transport. While cargo doors may be locked using conventional locking devices, they are typically easily defeated by the use of bolt cutters or other means to destroy the locking mechanisms. In the case of

hazardous liquids or gases, however, it may be easy for thieves to stop a vehicle and to release hazardous liquids or gases into the environment, or into another container for later use by the thieves.

[0006] Therefore, what is needed is a system for controlling a hazardous material valve on a vehicle in the event of an accident, vehicle malfunction, or theft. It would be ideal to have such a control system operate without user intervention.

### **SUMMARY**

[0007] In one embodiment, a method for controlling a valve located on a vehicle comprises detecting a hazard event and controlling the valve upon the occurrence of the hazard event. In one embodiment, the hazard event is detected from a condition of the vehicle. In another embodiment, the hazard event is detected from an input received from a vehicle operator. In yet another embodiment, the hazard event is detected from a message received from a remote location.

[0008] In another embodiment, an apparatus for controlling a valve located on a vehicle comprises means for detecting a hazard event, means for operating the valve, and means for controlling operation of the valve when a hazard event is detected.

[0009] In another embodiment, an apparatus for controlling a valve located on a vehicle comprises a transducer for detecting a hazard event, a solenoid for controlling operation of the valve, and a processor for detecting the hazard event and for sending a signal to the solenoid to control the solenoid upon the occurrence of the hazard event.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0010] The foregoing aspects and the attendant advantages of the embodiments described herein will become more readily apparent by reference to the following detailed description when taken in conjunction with the accompanying drawings wherein:

FIG. 1 shows a vehicle that includes one embodiment of a valve control system for detecting a hazard event;

FIG. 2 shows a detailed functional diagram of one embodiment of the valve control system of FIG. 1; and

FIG. 3 shows one embodiment of a method for operating the valve control system of FIG. 1.

## DETAILED DESCRIPTION

- [0011] The following detailed description describes methods and apparatus for controlling a valve after detecting a “hazard event”, for use with a vehicle that is transporting hazardous material. It should be understood that the described embodiments could also be used in conjunction with virtually any type of vehicle including, but not limited to, trucks, buses, trains, aircraft, automobiles, and watercraft.
- [0012] FIG. 1 shows a vehicle **100** that includes one embodiment of a valve control system **112** (shown in Fig. 2). The vehicle **100** in this example comprises a tanker truck, commonly used to transport hazardous liquids, such as propane, gasoline, etc. The vehicle **100** may comprise a mobile communication terminal (MCT, not shown) for communicating with one or more remote locations using, in this embodiment, a satellite-based wireless communication system. Other types of wireless communication systems could be used in the alternative, or in addition to, the satellite communication system, such as a terrestrial cellular communication system, a wireless packet data communication system, radio frequency communication system (e.g., FM, AM, LMR systems), and so on. The satellite communication system provides two-way communications between vehicle **100** and third parties, such as a fleet management center or dispatch center, family members, governmental authorities, consignees, shippers, and so on.
- [0013] Valve control system **112** is used to detect a “hazard event” and to control operation of a valve as part of vehicle **100** after the hazard event is detected. A hazard event is generally defined as an event that indicates that the hazardous material being transported by vehicle **100** may create a danger health or safety risk to people or the environment, whether vehicle **100** has been involved in an accident, malfunction, hijacking, or other emergency, or whether the vehicle has received notification from a remote location that valve control system **112** should be controlled for a reason either related to, or unrelated to, vehicle **100**.
- [0014] In one embodiment, remote location **102** comprises a central processing center, otherwise known as a central station, hub, or network management center (NMC), and serves as a central communication point between MCT-equipped vehicles and their respective dispatch centers, other designated office(s), shippers, consignees, governmental authorities, family members, and so on. For example, remote location **102** may pass communications between remote location **104** and vehicle **100**. In this embodiment, remote location **104** comprises a vehicle dispatch center that generally monitors and/or communicates with a fleet of vehicles similar to vehicle **100**.
- [0015] Communications between remote location **104** and vehicle **100** may further be passed to one or more other remote locations, such as remote location **106**. Remote

location **106** comprises one of any number of interested third parties that are interested in communications between remote location **104** and vehicle **100**. For example, remote location **106** could be another designated office of remote location **104**, a shipper of materials being carried by vehicle **100**, a consignee of materials being carried by vehicle **100**, a governmental unit, an individual, and so on. Communications among remote locations **102**, **104**, and **106** may be carried out by any known communication techniques, including telephone, Internet, dedicated lines, wireless links, and so on.

[0016] The MCT located on vehicle **100** transmits and receives communications wirelessly using, in one embodiment, a satellite-based wireless communication system to communicate with remote location **102**. Other wireless systems could be used in addition or in the alternative, such as an analog or a digital cellular telephone system, an RF communication system, or a wireless data communication network, such as a cellular digital packet data (CDPD) network. In other embodiments, the MCT may communicate directly with interested parties, such as remote locations **104**, and **106**, without communicating through remote location **102**. Thus, it is possible for information determined by valve control system **112** to be transmitted to one or more remote locations, as discussed above, or for valve control system **112** to receive commands from one or more remote locations.

[0017] In one embodiment, the valve control system **112** comprises a communication link that which allows communication with an on-board MCT to allow communication between the valve control system **112** and remote location via the MCT. In another embodiment, valve control system **112** comprises its own circuitry for allowing wireless communications between valve control system **112** and a remote location. In yet another embodiment, valve control system **112** is not capable of communicating with remote entities at all.

[0018] The valve control system **112** is coupled to one or more vehicle systems and/or vehicle sensors to determine when a hazard event has occurred. For example, valve control system **112** may have connections to vehicle lights, horns, alarms, ignition or other engine systems, and/or cargo mechanisms, such as control valves, door locks, fire control systems, heating or cooling systems, environmental detectors (e.g., a Geiger counter, a temperature sensor, a smoke detector, a pressure sensor), or other systems. The valve control system **112** may also have connections to various vehicle sensors, such as engine sensors, accelerometers, temperature sensors, speed sensors, position sensors (i.e., GPS system), or roll-over sensors. The valve control system **112** uses the information from these sensors to determine if a hazard event has occurred, i.e., whether the hazardous material carried by vehicle **100** poses a health or environmental threat, whether vehicle **100** has been involved in an accident, hijacking, or other emergency, or

whether the vehicle has received notification from a remote location that valve control system **112** should be activated.

[0019] FIG. 2 shows a detailed functional diagram of one embodiment of the valve control system **112**. The valve control system **112** comprises a processor **200**, memory **202**, sensor interface **204**, valve control interface **206**, and optional transceiver **208**. It should be understood that the elements shown in FIG. 2 are for illustrative purposes only, and that implementation of the valve control system **112** could be achieved in one of any number of ways using greater or fewer functional elements. For example, sensor interface **204** and valve control interface **206** could comprise the same physical hardware.

[0020] The processor **200** may comprise a CPU, gate array, logic, discrete circuitry, software, or any combination of hardware and software. The processor **200** receives various vehicle sensor inputs from sensor interface **204**. Sensor interface **204** typically comprises electronic signals from, for example, an accelerometer, a Geiger counter, a roll-over detector, a temperature sensor, an input from a vehicle operator, an input from a remote location, and so on.

[0021] In one embodiment, the processor **200** operates to execute instructions stored in the memory **202** to perform the functions described herein. The instructions may be stored in the memory **202** during manufacture of the valve control system **112**. In one embodiment, the instructions are stored on a computer-readable media, such as a floppy disk, hard disk, CDROM, flash memory, or any other type of computer-readable media. Alternatively, the instructions be received via the transceiver **208** or through sensor interface **204**.

[0022] During operation of the valve control system **112**, the processor **202** operates to detect that a hazard event has occurred, as defined above. In one embodiment, the hazard event is an event that occurs to the hazardous material itself. For example, the hazard event may comprise an increase or decrease in temperature, pressure, volume, or other physical property of the hazardous material as sensed by corresponding on-board sensors. Typically, a hazard event is declared by processor **200** if one or more physical properties of the hazardous material exceeds a predetermined threshold.

[0023] In another embodiment, a hazard event comprises an indication from a sensor designed to monitor containment of the hazardous material. For example, a temperature sensor located outside a storage container on vehicle **100** may sense an increase or decrease in temperature due to leakage of the hazardous material, or a liquid sensor may detect the presence of hazardous liquid material outside the storage container. In this embodiment, a predetermined threshold is typically exceeded, causing processor **200** to declare that a hazard event has occurred.

[0024] In another embodiment, a hazard event comprises an event that occurs to vehicle **100**, such as an accident, malfunction, or hijacking that is detected by one or more vehicle sensors such as an accelerometer, air-bag deployment sensor, a microphone, etc. In another embodiment, the hazard event is based on input from the vehicle operator. For example, the vehicle operator may input an emergency code into the processor **200** via sensor interface **204** and the emergency code indicates that a hazard event has occurred.

[0025] In another embodiment, the hazard event is based on input received from a remote location. For example, central station **102** may transmit an emergency code to the vehicle via an MCT located on the vehicle or via transceiver **208**. The MCT/transceiver **208** relays the emergency code to the valve control system **112** via sensor interface **204** or directly to processor **200**, as the case may be. In response to the emergency code, the processor **200** determines that a hazard event has occurred. Of course, a hazard event may comprise one or more of the embodiments just mentioned.

[0026] Once processor **200** has determined that a hazard event has occurred, the valve control system **112** operates to respond by performing one or more response functions. In one embodiment, when a hazard event is detected, the valve control system **112** responds by controlling operation of a valve **210** located on vehicle **100**. Valve **210** is typically used to allow materials carried by vehicle **100** to be loaded and unloaded. Typically, liquid material is loaded into a tank carried by vehicle **100** by connecting a hose or other suitable mechanism to valve **210**. An operator generally opens valve **210** by mechanical means, such as a rotatable handle, which in turn positions a mechanical stop inside the valve to an “open” position, thus allowing the material to flow through the valve and into the tank. After the material has been loaded into the tank, the valve is closed by again turning the rotatable handle to a “closed” position, thereby positioning the internal mechanism to block the material from entering or being discharged from the tank.

[0027] In addition to being manually controlled by an operator, valve **210** may, in addition or, alternatively, be controlled by electronic means **212**, such as a solenoid actuator. The electronic means **212** is responsive to an electronic signal provided by valve control system **112**. For example, valve **210** can be opened, closed, or held in an open or closed position upon receipt of one or more signals from valve control system **112**. Such signals may be generated upon the occurrence of a hazard event or, in one embodiment, under normal loading and unloading operations. For example, if processor **200** determines that the pressure of a hazardous gas carried within a tank onboard vehicle **100** has exceeded a predetermined threshold, processor **206** may send an electronic signal to electronic means **212**, via valve control interface **206**, to open valve **210** slightly to allow some of the hazardous material to escape the tank, thereby

avoiding an explosion and possible major contamination of the environment surrounding vehicle **100**. In another example, a hazard event is declared by processor **200** when a vehicle **100** is involved in an accident, sensed by an accelerometer, air-bag sensor, or some other sensor onboard vehicle **100**. In this example, processor **200** may send an electronic signal to electronic means **212**, via valve control interface **206**, to close valve **210** or to keep valve **210** in a closed position.

[0028] Valve control system **112** may, alternatively or in addition to operating valve **210**, respond to a detected hazard event by outputting one or more status messages for transmission to a remote location using either transmitter **208** or, if transmitter **208** is not present, using an external wireless communication terminal, such as the MCT, for transmitting messages to one or more remote locations. Thus, it is possible for the valve control system **112** to alert personnel at the one or more remote locations when a hazard event occurs and other information, such as the nature of the hazard event, the location of vehicle **100** at the time of the hazard event, etc.

[0029] In one embodiment, a remote location transmits one or more response messages to valve control system **112** in response to receiving a status message. In this embodiment, valve control system **112** does not control valve **210** until a response message is received from a remote location, or if a response is not received within a predetermined time period. For example, if the valve control system **112** transmits a status message to central station **102** to inform central station **102** that material being carried by vehicle **100** has exceeded a predetermined temperature, central station **102** may respond with a response message that instructs the valve control system **112** to operate valve **210**, i.e., to open, close, or to have valve **210** remain in an open or closed position. The response messages are received either by transceiver **208** or by an external receiver, such as a receiver that is part of a the MCT, and provided to processor **200**.

[0030] FIG. 3 shows one embodiment of a method for controlling a valve located on a vehicle that is transporting hazardous material. The method is suitable for use in one or more embodiments of a valve control system as described herein. For the following description, it will be assumed that a vehicle **100** is transporting liquefied propane inside a tank carried by vehicle **100**.

[0031] In step **300**, valve control system **112** determines that a hazard event has occurred, based on signals received through sensor interface **204** and/or transceiver **208**. Sensor interface **204** is connected to one or more sensors located onboard vehicle **100**, such as a temperature sensor, a pressure sensor, an accelerometer, a Geiger counter, etc. Sensors could also include an input device, such as a keyboard, used by a vehicle operator to enter information into, for example, a mobile communication terminal located onboard vehicle **100**, or valve control system **112**. The hazard event comprises

an event that indicates that the hazardous material being transported by vehicle **100** may create a health or safety risk to people or the environment, whether vehicle **100** has been involved in an accident, has malfunctioned, been hijacked, is involved in some other emergency, or whether the vehicle has received notification from a local (i.e., vehicle operator via keyboard input) or remote location that valve control system **112** should be controlled for a reason either related to, or unrelated to, vehicle **100**.

[0032] In step **302**, the processor **200** sends an electronic signal to electronic means **212** to control valve **210**. The electronic signal may cause valve **210** to open, close, or remain in an open or closed position.

[0033] A valve control system for use with a vehicle transporting hazardous material has been described that operates to control a valve in response to a hazard event. Accordingly, while one or more embodiments of a valve control system have been illustrated and described herein, it will be appreciated that various changes can be made to the embodiments without departing from their spirit or essential characteristics. Therefore, the disclosures and descriptions herein are intended to be illustrative, but not limiting, of the scope of the embodiments, which is set forth in the following claims.

**I CLAIM:**